



This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

### Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

- + *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
- + *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
- + *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
- + *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

### About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at <http://books.google.com/>



The Branner Geological Library



LELAND • STANFORD JUNIOR • UNIVERSITY





*W. G. Mann*

*241. 294*

AN  
INQUIRY  
INTO THE  
DEPOSITION OF LEAD ORE,  
IN THE  
MINERAL VEINS  
OF  
SWALEDALE,  
YORKSHIRE.

BY  
LONSDALE BRADLEY, F.G.S.

STANFORD LIBRARY

LONDON:  
EDWARD STANFORD, 6, CHARING CROSS, S. W.  
1862.

210163

YBA 981.1 0907

LONDON: PRINTED BY W. CLOWES AND SONS, STAMFORD STREET

## PREFACE.

---

THE PRODUCTIVE and UNPRODUCTIVE portions of the mineral veins of Swaledale, as influenced by the strata through which they pass, have formed the subject of my investigations for some time. Originally, the inquiry was only intended for my own satisfaction ; but from a wish expressed by many of my Mining friends I determined to have the result lithographed in the form of a coloured Chart ; and in this shape that result was first announced to the public under the title of "Sections of the Mountain Limestone, Swaledale, Yorkshire ; showing Forty Dislocations or Veins of Lead-Ore, varying in Throws from One to Forty Fathoms, with the most productive and unproductive portions of each Vein."

To my surprise, however, I found that many of the subscribers to the Sections were gentlemen totally unconnected or unacquainted with Mines ; and to such persons, a coloured Plan or Chart would be anything but an interesting or useful document. I was therefore induced to arrange the plan in its present form, which enables me to add a letter-press explanation containing the results of well-ascertained facts and of my own observations ; and these I venture to think may not be uninteresting in connection with the Sections.



I desire here to express my thanks to the lessees of the several mines in Swaledale, for the ready co-operation they have afforded me in obtaining the required information ; and more especially my acknowledgments are due to the undermentioned mine-agents in their employ for the valuable assistance they have rendered me in making out the returns of their respective districts :—

Messrs. JOHN and ROBERT LOWES, the West-Swaledale and Blakethwaite Mines.

Mr. THOMAS COATES, the Old Gang and Arkengarthdale Mines.

Mr. THOMAS RAW, the Surrender and Grinton Mines.

Mr. ROBERT DAYKIN, the Hurst and Fell-End Mines.

To Mr. MILNER, of Reeth, I am indebted for the Beldi-hill, Whitaside, Summer-Lodge, and Beesy Mine returns.

I may also remark, that my object in bringing the results of these investigations before the public has been not to confirm any existing theory, or to advance a new one formed merely upon local observations, on the general formation of lead-ores or other mineral substances found in metallic lodes or veins—but to record such facts connected with the veins of Swaledale, and to place them in such a light that they may be read and understood by the intelligent miner ; that they may serve as a guide to the mine agent ; that they may be useful as a matter of reference to the mining adventurer, and that they may be found not uninteresting to the scientific observer.

# CONTENTS.

---

PREFACE .. .. .	PAGE iii—v
-----------------	---------------

## CHAPTER I.

Mountain Limestone strata of Swaledale .. .. .	1
Limestone .. .. .	2—3
Chert .. .. .	4
Grit .. .. .	5
Plate or Shale .. .. .	5—9

## CHAPTER II.

Veinstone or Rider .. .. .	10—12
----------------------------	-------

## CHAPTER III.

Examination of Returns:— <i>Veins of 1 Fathom Throw</i> :—West-Swaledale, Blakethwaite, Beldi-Hill, Old Gang, Surrender, Hurst, Whitaside, Grinton-Moor, Ellerton-Moor, Arkengarthdale, and Fell-End Mines. Plate I. .. .. .		13—16
<i>Veins of 2 Fathoms Throw</i> :—West-Swaledale, Blakethwaite, Old Gang, Surrender, Hurst, Arkengarthdale, and Fell-End Mines. Plate I.		17—19
<i>Veins of 3 Fathoms Throw</i> :—West-Swaledale, Blakethwaite, Old Gang, Surrender, Hurst, Arkengarthdale, and Fell-End Mines. Plate I.		20—22
<i>Veins of 4 Fathoms Throw</i> :—Blakethwaite, Old Gang, Surrender, Hurst, Arkengarthdale, and Fell-End Mines. Plate I. .. .. .		22
<i>Veins of 5 Fathoms Throw</i> :—Blakethwaite, Old Gang, and Hurst Mines. Plate II. .. .. .		23
<i>Veins of 6 Fathoms Throw</i> :—Blakethwaite, Beldi-Hill, Hurst, Whitaside, and Arkengarthdale Mines. Plate II. .. .. .		23

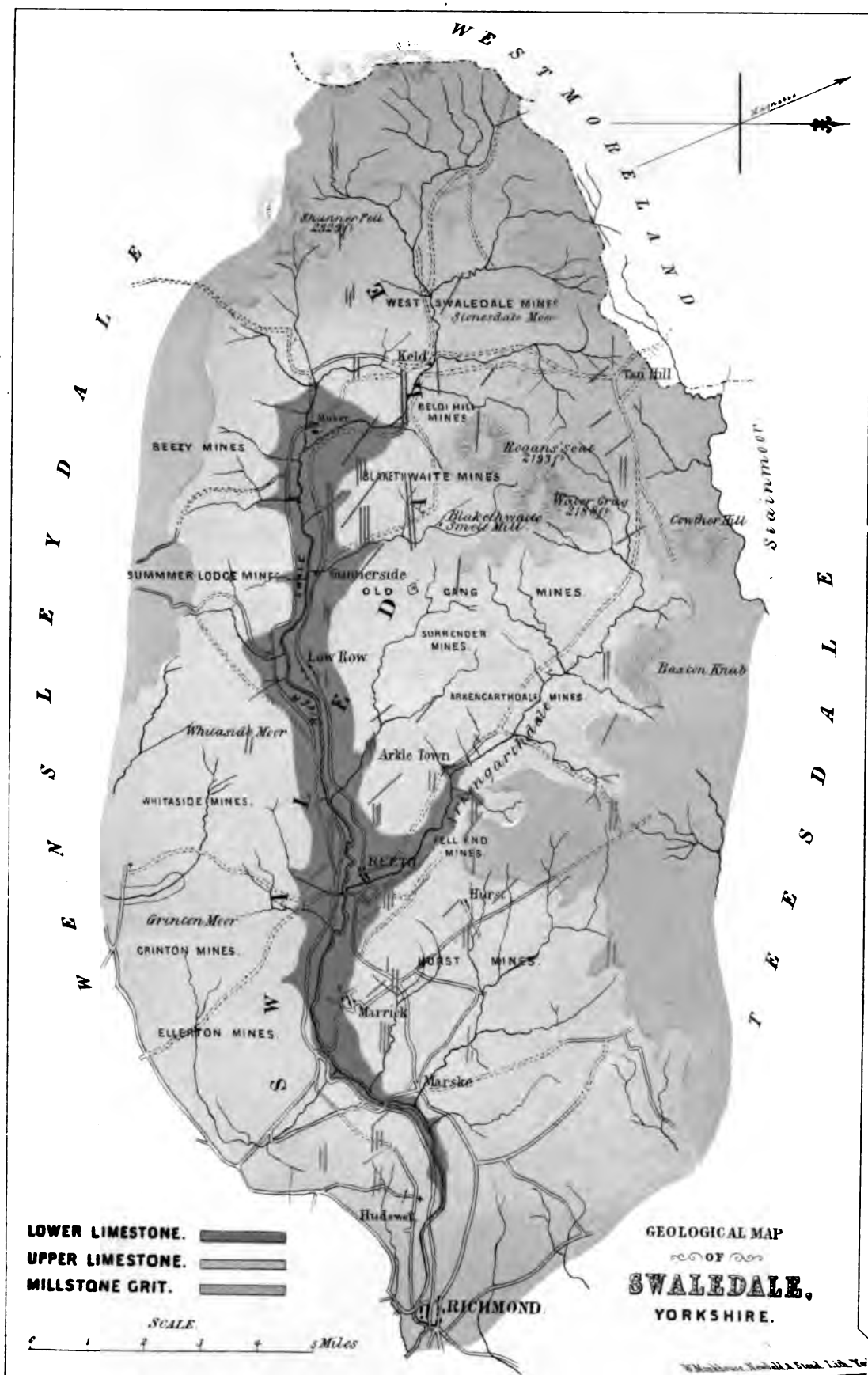
	PAGE
<i>Veins of 7 Fathoms Throw:—West-Swaledale, Blakethwaite, and Hurst Mines. Plate II.</i> .. .. .	24
<i>Veins of 8 Fathoms Throw:—West-Swaledale, Blakethwaite, Grinton Moor, and Arkengarthdale Mines. Plate II.</i> .. .. .	25
<i>Veins of 9 Fathoms Throw:—Old Gang and Hurst Mines. Plate III.</i> ..	25
<i>Veins of 10 Fathoms Throw:—West-Swaledale and Fell-End Mines. Plate III.</i> .. .. .	25
<i>Veins of 11 Fathoms Throw:—Fell-End Mines. Plate III.</i> .. .. .	26
<i>Veins of 12 Fathoms Throw:—Blakethwaite, Hurst, Whitaside, Arkengarthdale, and Fell-End Mines. Plate III.</i> .. .	26
<i>Veins of 13 Fathoms Throw:—Blakethwaite. Plate IV.</i> .. .	27
<i>Veins of 14 Fathoms Throw:—Hurst. Plate IV.</i> .. .. .	27
<i>Veins of 15 Fathoms Throw:—Hurst, Arkengarthdale, and Fell-End Mines. Plate IV.</i> .. .. .	27
<i>Veins of 16 Fathoms Throw:—Hurst and Fell-End Mines. Plate IV.</i> ..	27
<i>Veins of 18 Fathoms Throw:—Arkengarthdale Mines. Plate V.</i> .. ..	28
<i>Veins of 26 Fathoms Throw:—Arkengarthdale Mines. Plate VII.</i> .. ..	28
<i>Veins of 27 Fathoms Throw:—Grinton-Moor and Ellerton-Moor Mines. Plate VII.</i> .. .. .	28
<i>Veins of 28 Fathoms Throw:—Beldi-Hill, Old Gang, Surrender, and Fell-End Mines. Plate VII.</i> .. .. .	29
<i>Veins of 30 to 40 Fathoms Throw:—Hurst and Arkengarthdale Mines. Plates VIII. to X.</i> .. .. .	29

## CHAPTER IV.

<i>Synopsis of Returns:—Productive and Unproductive Veins.</i>							<i>Top Sets.</i>	<i>Main</i>
	<i>Sets.</i>	<i>Under Sets.</i>	..	..	..	..	..	30—32
<i>Veins of 1 Fathom Throw and under</i>	..	..	..	..	..	..	..	33
“ 2	“	“	..	..	..	..	..	34
“ 3	“	“	..	..	..	..	..	34
“ 4	“	“	..	..	..	..	..	34
“ 5	“	“	..	..	..	..	..	35
“ 6	“	“	..	..	..	..	..	35
“ 7	“	“	..	..	..	..	..	35
“ 8	“	“	..	..	..	..	..	35
“ 9	“	“	..	..	..	..	..	36







LIBRARY  
Lc.

# Reference Plate.

**MOST PRODUCTIVE PORTION OF THE VEIN**  
**(WITH OR WITHOUT RIDER) COLOURED THUS**



**PRODUCTIVE IN THE PRESENCE OF A RIDER**



**UNCERTAIN PORTIONS**



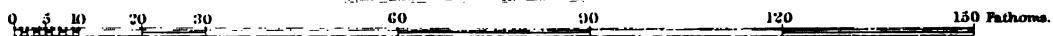
**UNPRODUCTIVE**



**UNEXPLORED**



**SCALE;— 30 Fathoms to an Inch.**





1908  
Leland Stanford, Jr.  
UNIVERSITY

# VEINS

## WITH THROWS

### OF

## ONE, TWO, THREE AND FOUR

### FATHOMS.

1	2	3	4
MILLSTONE GRIT	MILLSTONE GRIT	MILLSTONE GRIT	MILLSTONE GRIT
COAL			COAL
PLATE	PLATE	PLATE	PLATE
FLINTY CHERT	FLINTY CHERT	FLINTY CHERT	FLINTY CHERT
PLATE	PLATE	PLATE	PLATE
CROW CHERT	CROW CHERT	CROW CHERT	CROW CHERT
CROW LIME	CROW LIME	CROW LIME	CROW LIME
10 FATHOMS	10 FATHOMS	10 FATHOMS	10 FATHOMS
GRIT	GRIT	GRIT	GRIT
PLATE	PLATE	PLATE	PLATE
IRON BEDS	IRON BEDS	IRON BEDS	IRON BEDS
RED BEDS	RED BEDS	RED BEDS	RED BEDS
LIMESTONE	LIMESTONE	LIMESTONE	LIMESTONE
PLATE	PLATE	PLATE	PLATE
BLACK BEDS	BLACK BEDS	BLACK BEDS	BLACK BEDS
LIMESTONE	LIMESTONE	LIMESTONE	LIMESTONE
MAIN CHERT	MAIN CHERT	MAIN CHERT	MAIN CHERT
12 FATHOMS	12 FATHOMS	12 FATHOMS	12 FATHOMS
LIMESTONE	LIMESTONE	LIMESTONE	LIMESTONE
GRIT	GRIT	GRIT	GRIT
PLATE	PLATE	PLATE	PLATE
MIDDLE CHERT	MIDDLE CHERT	MIDDLE CHERT	MIDDLE CHERT
PLATE	PLATE	PLATE	PLATE
UNDERSET CHERT	UNDERSET CHERT	UNDERSET CHERT	UNDERSET CHERT
UNDERSET LIME	UNDERSET LIME	UNDERSET LIME	UNDERSET LIME
27 FATHOMS	27 FATHOMS	27 FATHOMS	27 FATHOMS
COAL			COAL
GRIT	GRIT	GRIT	GRIT
PLATE	PLATE	PLATE	PLATE
3 <sup>rd</sup> LIMESTONE	3 <sup>rd</sup> LIMESTONE	3 <sup>rd</sup> LIMESTONE	3 <sup>rd</sup> LIMESTONE
GRIT	GRIT	GRIT	GRIT
4 <sup>th</sup> LIMESTONE	4 <sup>th</sup> LIMESTONE	4 <sup>th</sup> LIMESTONE	4 <sup>th</sup> LIMESTONE
GRIT	GRIT	GRIT	GRIT
5 <sup>th</sup> LIMESTONE	5 <sup>th</sup> LIMESTONE	5 <sup>th</sup> LIMESTONE	5 <sup>th</sup> LIMESTONE
GRIT	GRIT	GRIT	GRIT
PLATES AND	PLATES AND	PLATES AND	PLATES AND
GRITS	GRITS	GRITS	GRITS

SCALE

0 5 10 20 30 40 50 Fathoms



**FATHOMS.**

MILLSTONE GRIT	MILLSTONE GRIT	MILLSTONE GRIT	MILLSTONE GRIT	MILLSTONE GRIT
GRIT		GRIT		GRIT
COAL				COAL
PLATE	PLATE	PLATE	PLATE	PLATE
FLINTY CHERT	FLINTY CHERT	FLINTY CHERT	FLINTY CHERT	FLINTY CHERT
PLATE	PLATE	PLATE	PLATE	PLATE
CROWN CHERT	CROWN CHERT	CROWN CHERT	CROWN CHERT	CROWN CHERT
CROWN LIME	CROWN LIME	CROWN LIME	CROWN LIME	CROWN LIME
10 FATHOMS	10 FATHOMS	10 FATHOMS	10 FATHOMS	10 FATHOMS
GRIT	GRIT	GRIT	GRIT	GRIT
PLATE	PLATE	PLATE	PLATE	PLATE
IRON BEDS	IRON BEDS	IRON BEDS	IRON BEDS	IRON BEDS
RED BEDS	RED BEDS	RED BEDS	RED BEDS	RED BEDS
LIMESTONE	LIMESTONE	LIMESTONE	LIMESTONE	LIMESTONE
PLATE	PLATE	PLATE	PLATE	PLATE
MAIN CHERT	MAIN CHERT	MAIN CHERT	MAIN CHERT	MAIN CHERT
12 FATHOMS	12 FATHOMS	12 FATHOMS	12 FATHOMS	12 FATHOMS
LIMESTONE	LIMESTONE	LIMESTONE	LIMESTONE	LIMESTONE
GRIT	GRIT	GRIT	GRIT	GRIT
PLATE	PLATE	PLATE	PLATE	PLATE
PLATE	PLATE	PLATE	PLATE	PLATE
UNDERSET CHERT	UNDERSET CHERT	UNDERSET CHERT	UNDERSET CHERT	UNDERSET CHERT
UNDERSET LIME	UNDERSET LIME	UNDERSET LIME	UNDERSET LIME	UNDERSET LIME
27 FATHOMS	27 FATHOMS	27 FATHOMS	27 FATHOMS	27 FATHOMS
GRIT	GRIT	GRIT	GRIT	GRIT
PLATE	PLATE	PLATE	PLATE	PLATE
3 <sup>rd</sup> LIMESTONE	3 <sup>rd</sup> LIMESTONE	3 <sup>rd</sup> LIMESTONE	3 <sup>rd</sup> LIMESTONE	3 <sup>rd</sup> LIMESTONE
GRIT	GRIT	GRIT	GRIT	GRIT
4 <sup>th</sup> LIMESTONE	4 <sup>th</sup> LIMESTONE	4 <sup>th</sup> LIMESTONE	4 <sup>th</sup> LIMESTONE	4 <sup>th</sup> LIMESTONE
GRIT	GRIT	GRIT	GRIT	GRIT
5 <sup>th</sup> LIMESTONE	5 <sup>th</sup> LIMESTONE	5 <sup>th</sup> LIMESTONE	5 <sup>th</sup> LIMESTONE	5 <sup>th</sup> LIMESTONE
PLATES AND	PLATES AND	PLATES AND	PLATES AND	PLATES AND
GRIT	GRIT	GRIT	GRIT	GRIT

6. \_\_\_\_\_ 7. \_\_\_\_\_ 8. \_\_\_\_\_ 9. Follow-up: \_\_\_\_\_



# VEINS

## WITH THROWS

### OF

#### NINE, TEN, ELEVEN AND TWELVE

#### FATHOMS.

9	10	11	12
MILLSTONE		MILLSTONE	
GRIT		GRIT	
COAL			MILLSTONE
	PLATE		COAL
PLATE		PLATE	
	FLINTY CHERT		PLATE
FLINTY CHERT		FLINTY CHERT	
PLATE	PLATE	PLATE	FLINTY CHERT
COAL CHERT	COAL CHERT	COAL CHERT	PLATE
COAL LINE	COAL LINE	COAL LINE	COAL CHERT
	10 FATHOMS		COAL LINE
10 FATHOMS		10 FATHOMS	
GRIT	GRIT	GRIT	10 FATHOMS
	PLATE		GRIT
PLATE	IRON BEDS	PLATE	PLATE
IRON BEDS	RED BEDS	IRON BEDS	IRON BEDS
RED BEDS	LIMESTONE	RED BEDS	RED BEDS
LIMESTONE	IRON CHERT	LIMESTONE	RED BEDS
IRON CHERT		IRON CHERT	LIMESTONE
	12 FATHOMS		PLATE
12 FATHOMS	LIMESTONE	12 FATHOMS	LIMESTONE
LIMESTONE		LIMESTONE	IRON CHERT
	GRIT		IRON CHERT
GRIT	PLATE	GRIT	
PLATE	UNDERST CHERT	PLATE	12 FATHOMS
UNDERST CHERT	UNDERST LINE	UNDERST CHERT	LIMESTONE
UNDERST LINE		UNDERST LINE	GRIT
	27 FATHOMS		PLATE
27 FATHOMS	GRIT	27 FATHOMS	PLATE
COAL		GRIT	UNDERST CHERT
GRIT	PLATE		UNDERST LINE
PLATE	5 <sup>th</sup> LIMESTONE	PLATE	
5 <sup>th</sup> LIMESTONE		GRIT	27 FATHOMS
GRIT	GRIT	5 <sup>th</sup> LIMESTONE	GRIT
4 <sup>th</sup> LIMESTONE	4 <sup>th</sup> LIMESTONE	GRIT	PLATE
	GRIT	4 <sup>th</sup> LIMESTONE	5 <sup>th</sup> LIMESTONE
GRIT	5 <sup>th</sup> LIMESTONE	GRIT	GRIT
5 <sup>th</sup> LIMESTONE	PLATES	5 <sup>th</sup> LIMESTONE	4 <sup>th</sup> LIMESTONE
GRIT	GRITS	GRIT	GRIT
			5 <sup>th</sup> LIMESTONE
			GRIT

SCALE

0 10 20 30 40 50 60 Fathoms



# VEINS

## WITH THROWS

### OF

#### THIRTEEN, FOURTEEN, FIFTEEN AND SIXTEEN

#### FATHOMS.

13	14	15	16
MILLSTONE		MILLSTONE	
COAL	PLATE	GRIT	PLATE
GRIT			COAL
COAL			GRIT
	FLINTY CHERT		FLINTY CHERT
PLATE	PLATE	PLATE	PLATE
	CROWN CHERT		CROWN CHERT
	CROWN LIME		CROWN LIME
FLINTY CHERT	10 FATHOMS	FLINTY CHERT	10 FATHOMS
PLATE	GRIT	PLATE	GRIT
CROWN CHERT		CROWN CHERT	
CROWN LIME		CROWN LIME	
10 FATHOMS	PLATE	10 FATHOMS	PLATE
GRIT	IRON BEDS	GRIT	IRON BEDS
PLATE	RED BEDS	PLATE	RED BEDS
IRON BEDS	RED BEDS	IRON BEDS	RED BEDS
PLATE	BLACK BEDS	PLATE	BLACK BEDS
RED BEDS	BLACK BEDS	RED BEDS	BLACK BEDS
LIMESTONE	LIMESTONE	LIMESTONE	LIMESTONE
PLATE	MAIN CHERT	PLATE	MAIN CHERT
BLACK BEDS	12 FATHOMS	BLACK BEDS	12 FATHOMS
LIMESTONE	LIMESTONE	LIMESTONE	LIMESTONE
MAIN CHERT	GRIT	MAIN CHERT	GRIT
12 FATHOMS	PLATE	12 FATHOMS	PLATE
LIMESTONE	PLATE	LIMESTONE	PLATE
GRIT	UNDERSET CHERT	GRIT	UNDERSET CHERT
PLATE	UNDERSET LIME	PLATE	UNDERSET LIME
UNDERSET CHERT	27 FATHOMS	UNDERSET CHERT	27 FATHOMS
UNDERSET LIME	GRIT	UNDERSET LIME	GRIT
27 FATHOMS	PLATE	27 FATHOMS	PLATE
COAL	3 <sup>rd</sup> LIMESTONE	COAL	3 <sup>rd</sup> LIMESTONE
GRIT	GRIT	GRIT	GRIT
PLATE	4 <sup>th</sup> LIMESTONE	PLATE	4 <sup>th</sup> LIMESTONE
3 <sup>rd</sup> LIMESTONE	GRIT	3 <sup>rd</sup> LIMESTONE	GRIT
GRIT	5 <sup>th</sup> LIMESTONE	GRIT	5 <sup>th</sup> LIMESTONE
4 <sup>th</sup> LIMESTONE	PLATES	4 <sup>th</sup> LIMESTONE	PLATES
GRIT	GRIT	GRIT	GRIT
5 <sup>th</sup> LIMESTONE	GRIT	5 <sup>th</sup> LIMESTONE	GRIT
GRIT	GRIT	GRIT	GRIT

SCALE

0 5 10 20 30 40 50 60 70 Fathoms





# VEINS

## WITH THROWS

### OF

#### SEVENTEEN, EIGHTEEN, NINETEEN AND TWENTY

#### FATHOMS.

17	18	19	20	
MILLSTONE	PLATE	MILLSTONE	PLATE	MILLSTONE
COAL		COAL		COAL
GRIT	FLINTY CHERT	GRIT	FLINTY CHERT	GRIT
COAL	PLATE	COAL	PLATE	COAL
PLATE	CROW CHERT	PLATE	CROW CHERT	PLATE
	CROW LIME		CROW LIME	
FLINTY CHERT	10 FATHOMS	FLINTY CHERT	10 FATHOMS	FLINTY CHERT
PLATE	GRIT	PLATE	GRIT	PLATE
CROW CHERT	PLATE	CROW CHERT	PLATE	CROW CHERT
CROW LIME	IRON BEDS	CROW LIME	IRON BEDS	CROW LIME
10 FATHOMS	RED BEDS	10 FATHOMS	RED BEDS	10 FATHOMS
GRIT	LIMESTONE	GRIT	LIMESTONE	GRIT
PLATE	BLACK BEDS	PLATE	BLACK BEDS	PLATE
IRON BEDS	LIMESTONE	IRON BEDS	LIMESTONE	IRON BEDS
RED BEDS	MAIN CHERT	RED BEDS	MAIN CHERT	RED BEDS
LIMESTONE	12 FATHOMS	RED BEDS	12 FATHOMS	RED BEDS
PLATE	LIMESTONE	PLATE	LIMESTONE	PLATE
BLACK BEDS	GRIT	BLACK BEDS	GRIT	BLACK BEDS
LIMESTONE	PLATE	LIMESTONE	PLATE	LIMESTONE
MAIN CHERT	PLATE	MAIN CHERT	PLATE	MAIN CHERT
12 FATHOMS	UNDERSET CHERT	12 FATHOMS	UNDERSET CHERT	12 FATHOMS
LIMESTONE	UNDERSET LIME	LIMESTONE	UNDERSET LIME	LIMESTONE
GRIT	27 FATHOMS	GRIT	27 FATHOMS	GRIT
PLATE		PLATE		PLATE
MIDDLE GRIT		MIDDLE GRIT		MIDDLE GRIT
PLATE		PLATE		PLATE
UNDERSET CHERT	GRIT	UNDERSET CHERT	GRIT	UNDERSET CHERT
UNDERSET LIME	PLATE	UNDERSET LIME	PLATE	UNDERSET LIME
27 FATHOMS	3 <sup>rd</sup> LIMESTONE	27 FATHOMS	3 <sup>rd</sup> LIMESTONE	27 FATHOMS
COAL	GRIT	COAL	GRIT	COAL
GRIT	4 <sup>th</sup> LIMESTONE	GRIT	4 <sup>th</sup> LIMESTONE	GRIT
PLATE	GRIT	PLATE	GRIT	PLATE
2 <sup>nd</sup> LIMESTONE	5 <sup>th</sup> LIMESTONE	2 <sup>nd</sup> LIMESTONE	5 <sup>th</sup> LIMESTONE	2 <sup>nd</sup> LIMESTONE
GRIT	PLATES	GRIT	PLATES	GRIT
4 <sup>th</sup> LIMESTONE	4 <sup>th</sup>	4 <sup>th</sup> LIMESTONE	4 <sup>th</sup>	4 <sup>th</sup> LIMESTONE
GRIT	GRITS	GRIT	GRITS	GRIT
5 <sup>th</sup> LIMESTONE		5 <sup>th</sup> LIMESTONE		5 <sup>th</sup> LIMESTONE
GRIT		GRIT		GRIT





# VEINS

## WITH THROWS

### OF

## TWENTY ONE, TWENTY TWO, TWENTY THREE AND TWENTY FOUR FATHOMS.

21	22	23	24	
MILLSTONE	PLATE	MILLSTONE	PLATE	MILLSTONE
COAL	FLINTY CHERT	COAL	FLINTY CHERT	COAL
GRIT	PLATE	GRIT	PLATE	GRIT
COAL	CROW CHERT	COAL	CROW CHERT	COAL
	CROW LIME		CROW LIME	
PLATE	10 FATHOMS	PLATE	10 FATHOMS	PLATE
	GRIT		GRIT	
FLINTY CHERT	PLATE	FLINTY CHERT	PLATE	FLINTY CHERT
IRON BEDS	IRON BEDS	IRON BEDS	IRON BEDS	IRON BEDS
CROW CHERT	RED BEDS	CROW CHERT	RED BEDS	CROW CHERT
CROW LIME	LIMESTONE	CROW LIME	LIMESTONE	CROW LIME
10 FATHOMS	BLACK BEDS	10 FATHOMS	BLACK BEDS	10 FATHOMS
GRIT	LIMESTONE	GRIT	LIMESTONE	GRIT
PLATE	MAIN CHERT	PLATE	MAIN CHERT	PLATE
IRON BEDS	12 FATHOMS	IRON BEDS	12 FATHOMS	IRON BEDS
PLATE	LIMESTONE	PLATE	LIMESTONE	PLATE
RED BEDS	GRIT	RED BEDS	GRIT	RED BEDS
LIMESTONE	PLATE	LIMESTONE	PLATE	LIMESTONE
BLACK BEDS	IRON BEDS	BLACK BEDS	IRON BEDS	BLACK BEDS
LIMESTONE	PLATE	LIMESTONE	PLATE	LIMESTONE
MAIN CHERT	UNDERSET CHERT	MAIN CHERT	UNDERSET CHERT	MAIN CHERT
12 FATHOMS	UNDERSET LIME	12 FATHOMS	UNDERSET LIME	12 FATHOMS
LIMESTONE	27 FATHOMS	LIMESTONE	27 FATHOMS	LIMESTONE
GRIT		GRIT		GRIT
PLATE		PLATE		PLATE
MIDDLE CHERT		MIDDLE CHERT		MIDDLE CHERT
PLATE		PLATE		PLATE
UNDERSET CHERT	GRIT	UNDERSET CHERT	GRIT	UNDERSET CHERT
UNDERSET LIME		UNDERSET LIME		UNDERSET LIME
27 FATHOMS	PLATE	27 FATHOMS	PLATE	27 FATHOMS
COAL	3 <sup>rd</sup> LIMESTONE	COAL	3 <sup>rd</sup> LIMESTONE	COAL
GRIT	GRIT	GRIT	GRIT	GRIT
PLATE	4 <sup>th</sup> LIMESTONE	PLATE	4 <sup>th</sup> LIMESTONE	PLATE
3 <sup>rd</sup> LIMESTONE	GRIT	3 <sup>rd</sup> LIMESTONE	GRIT	3 <sup>rd</sup> LIMESTONE
GRIT	5 <sup>th</sup> LIMESTONE	GRIT	5 <sup>th</sup> LIMESTONE	GRIT
4 <sup>th</sup> LIMESTONE		4 <sup>th</sup> LIMESTONE		4 <sup>th</sup> LIMESTONE
GRIT	PLATES	GRIT	PLATES	GRIT
5 <sup>th</sup> LIMESTONE	AND	5 <sup>th</sup> LIMESTONE	AND	5 <sup>th</sup> LIMESTONE
GRIT	GRITS	GRIT	GRITS	GRIT

SCALE.

0 5 10 20 30 40 50 60 70 Fathoms



# VEINS

## WITH THROWS

### OF

#### TWENTY FIVE, TWENTY SIX, TWENTY SEVEN AND TWENTY EIGHT FATHOMS.

25	26	27	28
MILLSTONE	PLATE	MILLSTONE	PLATE
COAL	FLINTY CHERT	COAL	FLINTY CHERT
GRIT	PLATE	GRIT	PLATE
COAL	BROWN CHERT	COAL	BROWN CHERT
	IRON LIME		IRON LIME
PLATE	10 FATHOMS	PLATE	10 FATHOMS
	GRIT		GRIT
FLINTY CHERT	PLATE	FLINTY CHERT	PLATE
PLATE	IRON BEDS	PLATE	IRON BEDS
CROWN CHERT	PLATE	CROWN CHERT	PLATE
CROWN LIME	RED BEDS	CROWN LIME	RED BEDS
	LIMESTONE		LIMESTONE
10 FATHOMS	PLATE	10 FATHOMS	PLATE
GRIT	IRON BEDS	GRIT	IRON BEDS
	MAIN CHERT		MAIN CHERT
PLATE	12 FATHOMS	PLATE	12 FATHOMS
IRON BEDS	LIMESTONE	IRON BEDS	LIMESTONE
RED BEDS	GRIT	RED BEDS	GRIT
LIMESTONE	PLATE	LIMESTONE	PLATE
PLATE	PLATE	PLATE	PLATE
IRON BEDS	UNDERSET CHERT	IRON BEDS	UNDERSET CHERT
UNDERSET CHERT	UNDERSET LIME	UNDERSET CHERT	UNDERSET LIME
12 FATHOMS	27 FATHOMS	12 FATHOMS	27 FATHOMS
LIMESTONE		LIMESTONE	
GRIT		GRIT	
IRON BEDS	GRIT	IRON BEDS	GRIT
PLATE	PLATE	PLATE	PLATE
UNDERSET CHERT	UNDERSET CHERT	UNDERSET CHERT	UNDERSET CHERT
UNDERSET LIME	UNDERSET LIME	UNDERSET LIME	UNDERSET LIME
27 FATHOMS	3 <sup>rd</sup> LIMESTONE	27 FATHOMS	3 <sup>rd</sup> LIMESTONE
COAL	GRIT	COAL	GRIT
GRIT	4 <sup>th</sup> LIMESTONE	GRIT	4 <sup>th</sup> LIMESTONE
PLATE	GRIT	PLATE	GRIT
3 <sup>rd</sup> LIMESTONE	5 <sup>th</sup> LIMESTONE	3 <sup>rd</sup> LIMESTONE	5 <sup>th</sup> LIMESTONE
GRIT	GRIT	GRIT	GRIT
4 <sup>th</sup> LIMESTONE	PLATES	4 <sup>th</sup> LIMESTONE	PLATES
GRIT	GRIT	GRIT	GRIT
5 <sup>th</sup> LIMESTONE	GRIT	5 <sup>th</sup> LIMESTONE	GRIT
GRIT	GRIT	GRIT	GRIT
6 <sup>th</sup> LIMESTONE	GRIT	6 <sup>th</sup> LIMESTONE	GRIT
GRIT	GRIT	GRIT	GRIT
7 <sup>th</sup> LIMESTONE	GRIT	7 <sup>th</sup> LIMESTONE	GRIT
GRIT	GRIT	GRIT	GRIT
8 <sup>th</sup> LIMESTONE	GRIT	8 <sup>th</sup> LIMESTONE	GRIT
GRIT	GRIT	GRIT	GRIT

SCALE





# VEINS

## WITH THROWS

### OF

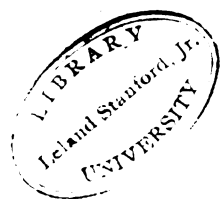
#### TWENTY NINE, THIRTY, THIRTY ONE AND THIRTY TWO FATHOMS.

29	30	31	32
MILLSTONE	PLATE	MILLSTONE	PLATE
PLASTY GROUT	PLASTY GROUT	PLASTY GROUT	PLASTY GROUT
PLATE	PLATE	PLATE	PLATE
GRIT	GRIT	GRIT	GRIT
GRIT	GRIT	GRIT	GRIT
PLATE	10 FATHOMS GRIT	PLATE	10 FATHOMS GRIT
PLATE	PLATE	PLATE	PLATE
PLATE	IRON BEDS	PLATE	IRON BEDS
PLATE	RED BEDS	PLATE	RED BEDS
PLATE	LIMESTONE	PLATE	LIMESTONE
PLATE	PLATE	PLATE	PLATE
10 FATHOMS GRIT	10 FATHOMS GRIT	10 FATHOMS GRIT	10 FATHOMS GRIT
PLATE	PLATE	PLATE	PLATE
IRON BEDS	IRON BEDS	IRON BEDS	IRON BEDS
PLATE	PLATE	PLATE	PLATE
RED BEDS	RED BEDS	RED BEDS	RED BEDS
LIMESTONE	LIMESTONE	LIMESTONE	LIMESTONE
PLATE	PLATE	PLATE	PLATE
UNDERST GROUT	UNDERST GROUT	UNDERST GROUT	UNDERST GROUT
UNDERST LINE	UNDERST LINE	UNDERST LINE	UNDERST LINE
10 FATHOMS LIMESTONE	10 FATHOMS LIMESTONE	10 FATHOMS LIMESTONE	10 FATHOMS LIMESTONE
GRIT	GRIT	GRIT	GRIT
PLATE	PLATE	PLATE	PLATE
PLATE	PLATE	PLATE	PLATE
UNDERST GROUT	UNDERST GROUT	UNDERST GROUT	UNDERST GROUT
UNDERST LINE	UNDERST LINE	UNDERST LINE	UNDERST LINE
27 FATHOMS	27 FATHOMS	27 FATHOMS	27 FATHOMS
GRIT	GRIT	GRIT	GRIT
PLATE	PLATE	PLATE	PLATE
PLATE	PLATE	PLATE	PLATE
UNDERST GROUT	UNDERST GROUT	UNDERST GROUT	UNDERST GROUT
UNDERST LINE	UNDERST LINE	UNDERST LINE	UNDERST LINE
27 FATHOMS	27 FATHOMS	27 FATHOMS	27 FATHOMS
GRIT	GRIT	GRIT	GRIT
PLATE	PLATE	PLATE	PLATE
2nd LIMESTONE	2nd LIMESTONE	2nd LIMESTONE	2nd LIMESTONE
GRIT	GRIT	GRIT	GRIT
4th LIMESTONE	4th LIMESTONE	4th LIMESTONE	4th LIMESTONE
GRIT	GRIT	GRIT	GRIT
PLATE	PLATE	PLATE	PLATE
2nd LIMESTONE	2nd LIMESTONE	2nd LIMESTONE	2nd LIMESTONE
GRIT	GRIT	GRIT	GRIT
4th LIMESTONE	4th LIMESTONE	4th LIMESTONE	4th LIMESTONE
GRIT	GRIT	GRIT	GRIT
5th LIMESTONE	5th LIMESTONE	5th LIMESTONE	5th LIMESTONE
GRIT	GRIT	GRIT	GRIT
5th LIMESTONE	5th LIMESTONE	5th LIMESTONE	5th LIMESTONE
GRIT	GRIT	GRIT	GRIT

SCALE

10 20 30 40 50 60 70 80 90 100





**FATHOMS.**

36

0	5	10	20	30	40	50	60	70	80	90 Fathoms
1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0
2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1
3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2
4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3
5.4	5.5	5.6	5.7	5.8	5.9	6.0	6.1	6.2	6.3	6.4
6.5	6.6	6.7	6.8	6.9	7.0	7.1	7.2	7.3	7.4	7.5
7.6	7.7	7.8	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6
8.7	8.8	8.9	9.0	9.1	9.2	9.3	9.4	9.5	9.6	9.7
9.8	9.9	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8
10.9	11.0	11.1	11.2	11.3	11.4	11.5	11.6	11.7	11.8	11.9
12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	12.9	13.0
13.1	13.2	13.3	13.4	13.5	13.6	13.7	13.8	13.9	14.0	14.1
14.2	14.3	14.4	14.5	14.6	14.7	14.8	14.9	15.0	15.1	15.2
15.3	15.4	15.5	15.6	15.7	15.8	15.9	16.0	16.1	16.2	16.3
16.4	16.5	16.6	16.7	16.8	16.9	17.0	17.1	17.2	17.3	17.4
17.5	17.6	17.7	17.8	17.9	18.0	18.1	18.2	18.3	18.4	18.5
18.6	18.7	18.8	18.9	19.0	19.1	19.2	19.3	19.4	19.5	19.6
19.7	19.8	19.9	20.0	20.1	20.2	20.3	20.4	20.5	20.6	20.7
20.8	20.9	21.0	21.1	21.2	21.3	21.4	21.5	21.6	21.7	21.8
21.9	22.0	22.1	22.2	22.3	22.4	22.5	22.6	22.7	22.8	22.9
23.0	23.1	23.2	23.3	23.4	23.5	23.6	23.7	23.8	23.9	24.0
24.1	24.2	24.3	24.4	24.5	24.6	24.7	24.8	24.9	25.0	25.1
25.2	25.3	25.4	25.5	25.6	25.7	25.8	25.9	26.0	26.1	26.2
26.3	26.4	26.5	26.6	26.7	26.8	26.9	27.0	27.1	27.2	27.3
27.4	27.5	27.6	27.7	27.8	27.9	28.0	28.1	28.2	28.3	28.4
28.5	28.6	28.7	28.8	28.9	29.0	29.1	29.2	29.3	29.4	29.5
29.6	29.7	29.8	29.9	30.0	30.1	30.2	30.3	30.4	30.5	30.6
30.7	30.8	30.9	31.0	31.1	31.2	31.3	31.4	31.5	31.6	31.7
31.8	31.9	32.0	32.1	32.2	32.3	32.4	32.5	32.6	32.7	32.8
32.9	33.0	33.1	33.2	33.3	33.4	33.5	33.6	33.7	33.8	33.9
34.0	34.1	34.2	34.3	34.4	34.5	34.6	34.7	34.8	34.9	35.0
35.1	35.2	35.3	35.4	35.5	35.6	35.7	35.8	35.9	36.0	36.1
36.2	36.3	36.4	36.5	36.6	36.7	36.8	36.9	37.0	37.1	37.2
37.3	37.4	37.5	37.6	37.7	37.8	37.9	38.0	38.1	38.2	38.3
38.4	38.5	38.6	38.7	38.8	38.9	39.0	39.1	39.2	3	



# AN INQUIRY INTO THE DEPOSITION OF LEAD-ORES, ETC.

---

## CHAPTER I.

It is my intention, in offering an explanation of the accompanying Sections, to give a short description of the Mountain Limestone formation of Swaledale, so far, at least, as the mineral characteristics of each different stratum affect the subject of these investigations. In doing so, let it be understood that the Millstone Grit caps most of the highest hills of Swaledale, and that the Fifth-set-Limestone, with a considerable thickness of alternate bands of Grit and Plate under it, forms the lowest observable Limestone bed in this Dale. It is also necessary to state that the intervening series of deposits, comprising Limestone, Chert, Grit, and Plate, is found by measurement to be 1050 feet in thickness. These four distinct and characteristic deposits may be thus designated:—

Limestone	...	...	...	Calcareous.
Chert	...	...	...	Silicio-calcareous.
Grit	...	...	...	Silicio-micaceous.
Plate	...	...	...	Argillaceous.

They are found in about the following proportions:—

				Fathoms.
Limestone	...	...	...	45
Chert	...	...	...	15
Grit	...	...	...	75
Plate	...	...	...	40

---

175 = 1050 feet.

---

On examining a section of the strata it is found that there are about thirty principal deposits, consisting of eight of Limestones, four of Cherts, seven of Grits, eight Plate or Shale beds, two thin seams of Coal, one Black bed, and one Iron bed, being hard silicious Limestones.

#### LIMESTONES.

The Limestones are by far the most important deposits, and those from which this series derives its name (Mountain Limestone), consist of eight calcareous beds, three of which occur above the Main, or Twelve-Fathoms, Limestone, and four below it.

The fossil remains of the Limestones, which are exceedingly numerous, have been beautifully drawn and described in Professor Phillips's Geology of Yorkshire.

It is worthy of remark, that, as appears from various analyses I have obtained, the higher deposits in the series, or, geologically speaking, the latest deposits, are by far the richest in carbonate of lime (see Table of Analysis of Limestone); and, as we descend in the order of superposition, it seems that the earlier the deposit the more silicious is its composition, until the Limestones gradually merge into Grits and Plates, and ultimately no doubt into the Old Red Sandstone. Limestones have a much more valuable attendant than the paleontological remains denominated fossils; and this is found in their metalliferous productions in the form of lead ores.

The Limestones are by far the most valuable deposits for the production of galena, though in Swaledale only four of these beds—"The Crow-Limestone," "The Red-beds Limestone," "The Main-Limestone," and "The Underset Limestone," have been properly explored by the miner. The fact that the veins

in the lower Limestones\* have not been more sought after and explored by the mining adventurer may be attributed to the following circumstances:—1st. the difficulty of winning the “Set,” without the use of expensive machinery; 2nd. the leasing of large tracts of country to small capitalists; 3rd. the high rate of royalties,† varying from  $\frac{1}{3}$ th to  $\frac{1}{2}$ th. As it is desirable in this investigation to ascertain which of the beds constituting this series are most productive of galena, and to discover, if possible, some reason for the productive character of the one “Set,” and the unproductive character of the other, it was considered necessary to obtain an analysis of the Limestones, Cherts, Grits, and Plates, in order that by comparing their composition we might ascertain what are the constituents of a productive, and what of an unproductive bed.

*Analyses of Limestones.*

	Red-beds Limestone.	Main Limestone.	Underset Limestone.
Hydroscopic Water ...	·21	·35	·37
Water of Combination ...	·20	·38	·41
Carbonate of Lime ...	96·58	85·53	79·75
Magnesia ...	·80	1·05	1·29
Oxides of Iron and Alumina	·40	·78	·93
Phosphoric Acid...	·07	·09	—
Sulphate of Lime ...	—	·39	—
Potash and Soda...	·10	·45	—
Insoluble silicious matter	1·64	10·98	17·25
	<hr/> 100·00 <hr/>	<hr/> 100·00 <hr/>	<hr/> 100·00 <hr/>

\* It may be well here to remark that in the adjoining mining district of Wensleydale the veins in the lower Limestones have in many places been explored, and with very satisfactory results; the Keld-Head Mines, the property of the Right Hon. Lord Bolton, having been very productive for some years in the lower Limestone “Set.”

† The royalties in Swaledale and Arkengarthdale belong to Sir George W. Denys, Bart. and others, George Gilpin Brown, Esq., Thomas Smith Esq., the Crown, W. S. E. Drax, Esq., and Francis Morley Esq.

## CHERT.

The Chert is a silicious, and to some extent calcareous, deposit, dark in colour, and extremely hard; though frequently presenting, as the result of long exposure to the atmosphere, the appearance of white flint.

It seems during the time of deposition, or at some period prior to the formation of the superincumbent strata, to have been subjected to a considerable increase of temperature, in connexion most probably with certain chemical changes by which it would appear that the lime and silica, along with the oxides of iron (owing to their affinity for one another), had formed a close and compact mass of the silicates of lime and iron. (See Analysis of Chert). Whether this be really the case or not we shall endeavour to prove at some future opportunity; it is now merely stated as probable, judging from the appearance of the Chert and its chemical composition. There exist but three principal Chert beds—"The Crow Chert," "The Main Chert," and "The Underset Chert," resting immediately on the three Limestones of the like names.

The Cherts rank as equal if not superior in the production of the ores of lead to any of the Limestones; though, from the thinness of the deposits, their productive qualities depend very materially upon the character of the vein.

*Analysis of Chert.*

Moisture and Water of Combination	...	...	...	2.25
Oxides of Iron and Alumina	...	...	...	2.24
Carbonate of Lime	...	...	...	37.49
Magnesia	...	...	...	1.14
Insoluble silicious matter	...	...	...	57.96
				101.08*

\* The excess in this analysis is caused, according to Dr. Voelcker, by the lime existing as a silicate of lime.

## GRIT.

Grit is a highly silicious and occasionally micaceous deposit, and is more commonly known as sandstone or freestone, consisting of more than three-fourths of silica (sand), the remaining portion being mica and the oxides of iron. Fossil remains in this formation are exceedingly scarce, amounting to, here and there, a decomposed specimen of a bivalve shell, or the impressions of stigmaria, sigillaria, &c.

The Grits constitute nearly *one-half of the whole carboniferous limestone series*, and are divided into six different deposits—"The Ten Fathoms Grit," "The Three Fathoms Grit," under the Main Limestone, "The Twenty-seven Fathoms Grit," and the Grits under the "Third," "Fourth," and "Fifth-set Limestones." The Grits may be classed as unproductive beds, except in such veins as carry a strong mineral Rider; then they have been known to be very productive.

*Analysis of Grit.*

Moisture and Water of Combination	...	...	...	1·12
Oxides of Iron and Alumina (chiefly iron)	...	...	...	·58
Carbonate of Lime	...	...	...	·17
Magnesia and Alkalies	...	...	...	·12
Insoluble silicious matter (sand)	...	...	...	98·01
				<hr/>
				100·00
				<hr/>

## PLATE OR SHALE.

The Plate or Shale is an argillaceous deposit of a more or less slaty or laminated structure, containing small bivalve and univalve shells, along with vegetable impressions and carbonised vegetable matter in the form of lignite. Many of the vegetable impressions are ferns, stigmaria and lepidodendrons of the coal



formation; whilst some of the fossil shells are small, so much so indeed as to require the aid of the microscope to discern their form, and it is probable that many are as yet undescribed in palæontological works.

Besides the organic remains of these deposits, there exist thin bands of Ironstone, as well as nodules of the same mineral, containing from 20 to 30 per cent. of metallic iron reduced principally from the peroxide and protoxide of iron, in connexion also with the sulphuret of iron or iron pyrites.

The Plate beds are shaly, laminated, and of a very tough or spongy character, containing a larger per centage of water than any of the other deposits. On exposure to the atmosphere, they readily crumble to pieces; and, instead of the black appearance presented when *in situ*, change to a dark, brownish-red colour through the conversion of the protoxide into the peroxide of iron.

The Plate or Shale belongs to the unproductive or non-metalliferous class of deposits.

*Analysis of Plate or Shale.*

Moisture	...	...	...	...	...	...	5.26
Water of Combination	...	...	...	...	...	...	4.92
Oxides of Iron and Alumina (containing phosphoric acid							
18)	...	...	...	...	...	...	2.79
Carbonate of Lime	...	...	...	...	...	...	5.90
Magnesia and Alkalies	...	...	...	...	...	...	.72
Insoluble silicious matter (chiefly fine clay)	...	...	...	...	...	...	80.41
							100.00

From this brief account of the four distinct characters of rock composing the series, it will be easy to understand that a difference in their mineral-producing qualities will be the result: for while the *Grits and Plates* may be classed as the *unproductive or non-metalliferous deposits*, the *Limestones and Cherts* are the *chief lead-ore producing beds*. Thus, to run over the principal rocks as they occur in their descending order, we shall find first

that the *Thick Plate* under the Millstone Grit is a non-metaliferous deposit; that is to say, veins traversing this bed are found to be worthless or unproductive in metallic ores. The bed varies from 20 to 30 fathoms in thickness, is tolerably hard, shaly, and consists of a series of silicious, calcareous, and argillaceous bands containing large quantities of nodular Ironstone, commonly called "catheads." Immediately below this thick Plate we arrive at the *Crow Limestone and Chert*, which are exceedingly productive deposits when the dislocation of the veins is slight and the beds are fully developed, as at the eastern extremity of the Dale. "The Crow beds" are generally from four to five fathoms in thickness, and the Chert is divided by thin lists or bands of argillaceous matter. The Limestone is of an open or porous character and extremely fossiliferous; its remains consist chiefly of the stems of encrinites, which occasionally occur in such masses as to have given it the name of "honey-comb" or "screw-stone" amongst the miners.

The *Ten Fathoms Grit*, which rests directly below the Crow Limestone, has also been productive under certain circumstances, more especially when the vein carries a Rider or Veinstone; and then more towards the top of the Grit or lower portion of the Crow beds than at the bottom where it assumes a slaty or shaly appearance. The upper portion of the "Ten Fathoms Grit"\* consists of fine-grained yellow or reddish-coloured sandstone, in seams varying from a few inches to two or three feet in thickness; it is of a hard, compact, and durable character. The lower division includes a series of arenaceo-argillaceous bands, and varies from two to nearly ten fathoms in thickness.

---

\* The term "Ten Fathoms Grit" is given to that portion of the strata extending from the Crow Limestone downwards to the Red-beds Limestone, and includes several Plate or Shale beds.

The *Red-beds Limestone* and the *Black-beds* have also been exceedingly productive under favourable dislocations of the veins. These beds are very variable, being much thicker in the eastern than in the western division of the Dale, and in consequence more productive in the former than in the latter.

The Red-beds Limestone is perhaps the most purely calcareous deposit we possess in the carboniferous Limestone of this district, containing, according to analysis, 96·58\* per cent. of carbonate of lime, and is a fine open granular Limestone.

The Black-beds are of a dark-brown or blackish colour, and partake more of the character of a Chert than of a Limestone deposit.

Two thin Plates and a compact Limestone bed of a few feet in thickness divide the Black-beds from the Main-Chert.

The *Main-Chert and Limestone* are by far the most valuable lead-ore producing beds throughout Swaledale, and from these beds there can be little doubt the principal portion of the lead-ore raised† has been obtained. From this fact they are the beds generally sought for, and for the working of which the highest skill of the mining engineer has been brought into use.

The Main-Chert is a silico-calcareous rock of a hard flinty structure, and is frequently divided into blocks, layers, or posts, generally homogeneous, and of a dark bluish-brown colour.

The Main or Twelve-Fathoms Limestone,—a fine-grained, hard, and compact Limestone, is commonly divided by the miner into three divisions or flats; and in caverns, at the bottom of these flats, are generally found the *horizontal deposits of lead-ore* accompanied with Wamp or Vamp (decomposed Limestone), called *floats* or *flats*.

---

\* Analysis by Dr. Voelcker.

† The annual yield of lead ore from the mines of Swaledale was in 1857 = 5,337 tons; 1858 = 6,576 tons; 1859 = 5,717 tons; 1860 = 4,878 tons; 1861 = 4,468 tons. —“Mineral Statistics,” by Robert Hunt, F.R.S.

The *Eight-Fathoms "Deading,"* consisting of Grits and Plates, is, as its name implies, generally speaking dead as regards the production of the ores of lead.

The *Underset Chert and Limestone* may also be considered as lead-ore-producing deposits, though not in the same degree as the Main-Limestone and Chert.

The *Twenty-seven Fathoms Grit* is, with few exceptions, the lowest worked stratum of the lead measures. Only in certain cases has it been productive of ore, and then invariably in a strong or powerful vein carrying a kindly Rider or Veinstone.\*

The *Third-set of Limestone*, of which very little trial has been made, varies much in thickness. Below this the beds are up to the present period unworked.

Without doubt the most practically interesting, and certainly the most profitable, portion of any scientific inquiry, is that which tends to establish by regularly arranged facts and observations the accuracy of what is asserted respecting the subject under consideration; all statements being liable to impeachment unless supported by reference to actual results.

With this object in view, I now proceed to examine the returns which have been furnished according to the proper forms, and in which are included most, if not the whole, of the veins of Swaledale in which explorations have been made. This will show the correctness of the accompanying Sections,† and corroborate the statements I have been induced to make on the very interesting and important subject of which I am treating.

---

\* The term "Rider" or "Veinstone" is here used to express the fragmentary portions of the strata, or crystalline mineral substances found in the vein or lode.

† I wish it to be distinctly understood that the Sections were drawn and printed in 1860, and entirely founded on observation, whilst the returns were only obtained in 1860 and 1861. Therefore any inaccuracies which may be discovered constitute the difference between the actual results as shown by the returns and the facts supposed to exist as the result of my own observations.

## CHAPTER II.

## VEINSTONE OR RIDER.

As a general rule, it may be stated that all veins contain more or less mineral matter between their sides, cheeks, or walls, which is known as the gangue or matrix of the vein; and that these substances, in whatever variety of form they may exist in the vein, receive the terms amongst miners of Rider or Veinstone, Whamp or Vamp, and Platy Sample or Douk, the first form being the most universal attendant of lead-ore in strong and productive veins. On this account then it was considered necessary to illustrate in the accompanying Sections those portions of the veins in which, according to facts obtained from others and the result of my own investigations, I have found to be the position in which these substances are formed and become productive of, or associated with, metallic ores.

After this statement it is desirable to define clearly the term Rider or Veinstone.

A Rider we may then assert is any *mineral matter* existing between the true or perfect sides, cheeks, or walls of a vein. This may be from a few inches to many fathoms in thickness, and admits of three forms which we shall designate as—

Fragmentary or Stony	...	...	...	Primary.
Crystalline or Sparry	...	...	...	Secondary.
Sedimentary or Earthy	...	...	...	Tertiary.

Of the Fragmentary or Primary Rider we possess three forms :—

The Limestone Rider,

The Chert Rider,

The Grit Rider,

or a mixture of the two, or occasionally of the three.

I am induced to call these primary Riders from the fact that they are broken portions of the adjacent beds, sometimes slightly changed or mineralised by the infiltration of other mineral substances, but possessing almost the same chemical composition and physical properties, and in many cases exhibiting the same vertical and horizontal fracture; while in more than one instance I have observed the broken or fragmentary remains of fossils belonging to the adjoining or opposite beds. Consequently we may conclude that the primary Riders were produced or formed simultaneously and contemporaneously with the formation of the vein.

Under the head of Crystalline or Secondary Riders I include all such crystalline mineral substances as are the products of the vein, such substances not being lead-ore, that being the result of some influence, either electrical or chemical, which is not conducive or perhaps only partially so to the formation of lead-ores. These substances may be enumerated as follows :—

Calcareous Spar (Carbonate of Lime).

Fluor Spar (Fluate of Lime).

Caulk or Cawk Spar (the Carbonate and Sulphate of Baryta).

Barytocalcite (Carbonate of Baryta and Lime).

Quartz Spar (Silica).

Iron Pyrites (Sulphuret of Iron).

Black Jack } (Oxides of Zinc).

Grey Jack }

In the class of Sedimentary or Tertiary Riders I include all the friable and tenacious earthy substances which are found in mineral veins, and named Whamp or Vamp, Douk or Donk, or Platy Sample. They comprise a variety of coloured soils and clays, the colour

being chiefly produced by the oxide of iron, and the substances owing their existence in these situations to the action of water, both chemically and mechanically :—chemically, by its decomposing or dissolving properties, by means of which water can take up a variety of soluble mineral substances in solution, such as lime, magnesia, soda, potash, iron, silica, alumina, &c., along with atmospheric air and carbonic acid gas ;—mechanically, by the process of attrition, or the wearing away by water of the surfaces of the rock over which it passes.

I have here made use of three terms—*Primary*, *Secondary*, and *Tertiary*, quite independently of their geological associations and simply to mark the different periods of the formation, accumulation, and general filling up of the veins or lodes with a variety of mineral substances ; it being conceived that these substances have been formed or produced at three different epochs, under different influences, and under totally different circumstances. The *primary* Rider is so termed because it is a broken portion of the bed or beds thrown in between the side cheeks, or walls of the vein, and consequently its origin is contemporary with the vein itself ; in the *secondary* Riders have the production or growth of all crystalline and metalliferous substances ; and in the *tertiary* we have the general filling up of the vein with sedimentary deposits chiefly from the integrated portions of the strata.

### CHAPTER III.

#### EXAMINATION OF RETURNS.

##### VEINS OF ONE FATHOM THROW AND UNDER.—PLATE I.

###### *West-Swaledale Mines.*

1. North String of the Sun-vein (Keld Side), productive in Main-Limestone, Chert, and Grit; Rider.
2. North Cross vein (Stonesdale), productive in Main-Chert; no Rider.
3. Sun String of North Cross vein (Stonesdale), productive in Main-Chert; no Rider.

###### *Blakethwaite Mines.*

4. Middle Branch, North vein, productive in Main-Limestone and Chert; Rider.
5. Sun-vein, or Dean's vein, productive in Main-Limestone and Chert; Rider.
6. Sun-vein, very rich in the whole of the Main-Limestone and Chert; little or no Rider.
7. Shield's String, productive in Main-Limestone; no Rider.
8. Dunn's Sun-String, productive in Main-Limestone and Chert; Rider. Other Strings attending this vein were productive in the same beds with two or three feet slips; Riders.



9. Strings attending Water Sykes vein, productive in Main Limestone; no Rider.

10. North String vein (Lownithwaite), productive in Underset Limestone and Chert; strong Rider.

11. Sun-vein Strings (Lownithwaite), productive in Main Limestone and Chert; no Riders.

12. Captain Metcalfe's Sun vein (Lownithwaite), productive in Main-Limestone and Red beds; no Rider.

13. Hutchinson's vein (Lownithwaite), productive in Main Limestone; no Rider.

14. North String of Middle vein (Swinnergill), productive in Main-Limestone and Chert; Rider.

15. Sun String of Middle vein (Swinnergill), productive in Main-Limestone and Chert; Rider.

*Beldihill Mines.*

16. Garvis vein, productive in Main-Limestone; no Rider.

17. Raw's vein, productive in Main-Limestone; no Rider.

*Old Gang Mines.*

18. Moorhouse vein, productive in Main-Limestone and Chert and Black beds; Rider.

19. North Rake vein, productive in all the principal bearing beds; strong Rider.

20. Brandy Bottle vein, productive in Main-Limestone and Chert; Rider.

21. Hazel-Keld vein, productive in Main-Limestone and Chert and Black beds; Rider.

22. Providence vein, productive in Black-beds and Red-beds; not much Rider.

23. Healaugh-Side vein, productive in Main-Limestone and Chert; not much Rider.

*Surrender Mines.*

24. Commodore vein, productive in Ten Fathoms Grit, Crow Limestone and Chert; no Rider.

25. Eel Tail vein, productive in Main-Limestone and Chert; not much Rider.

26. Nancy vein, productive in Main-Limestone and Chert; not much Rider.

27. Rachael String, productive in Main-Limestone, and Chert and Crow beds; not much Rider.

28. Metcalfe String, productive in Red-beds and Crow-beds; not much Rider.

29. Jacob Sun vein, productive in Main-Limestone and Chert and Crow-beds; not much Rider.

30. Water-Blast vein, productive in Main-Limestone and Chert; not much Rider.

*Hurst Mines.*

31. Jingle Pot vein, productive in Main-Limestone and Chert, and Black and Red-beds; Rider in some beds.

32. Grinton-Dam vein, productive in Main-Limestone and Chert, and Underset Limestone and Chert; small Rider.

33. Mole's vein, productive in Main-Limestone; not much Rider.

34. Flange vein, productive in Main-Limestone and Chert, and Black and Red beds; Rider.

35. Sun Strings, productive in Underset Limestone and Chert; Rider.

36. North String, Copperthwaite vein, productive in Main-Limestone and Chert, and Black and Red-beds; not much Rider.

37. Sun Hush vein, productive in Main-Limestone and Chert ; Rider.

*Whitaside Mines.*

38. Mudd's float, productive in Main-Limestone ; no Rider.

39. Murton float, productive in Main-Limestone ; no Rider.

*Grinton Moor Mines.*

40. Brownagill String, productive floats Main-Limestone ; no Rider.

41. Groove-Beck vein, productive floats Main-Limestone and Underset Limestone ; no Rider.

42. How vein, productive floats Main-Limestone ; no Rider.

43. Wellington vein, productive floats Main-Limestone ; no Rider.

44. Cryna-Bottom vein, productive in Red-beds ; no Rider.

*Ellerton Moor Mines.*

45. Redway-Head vein, productive in Main-Limestone and Red-beds ; no Rider.

46. Wellington vein, productive in all the principal bearing beds ; no Rider.

47. Heggs Gill vein, productive in Red-beds ; no Rider.

48. Jammy Raw's Rake vein, productive in Red-beds ; no Rider.

49. Chaytor's vein, productive in Main-Limestone and Red-beds ; no Rider.

50. Robinson's vein, productive in Red-beds ; Rider.

51. Cryna-Bottom vein, productive in Red-beds ; no Rider.

*Arkengarthdale Mines.*

52. Cobbler vein, productive in Main-Limestone ; no Rider.

53. North vein, productive in Main-Limestone, and Chert and Black and Red beds; Rider.

54. Stemple vein, productive in Main-Limestone, and Chert and Black-beds; Rider.

55. Black Jack vein, productive in Main-Limestone and Chert; Rider.

56. Chip vein, productive in all the principal bearing beds; Rider.

57. Luck's-All vein, productive in Main-Limestone and Chert; Rider.

58. Grey Game vein, unproductive.

59. Bishop Sun vein, unproductive.

60. Raisbeck vein, productive in Main-Limestone and Chert, and Underset Limestone and Chert; Rider.

61. Fagnergill Old-vein, productive in Main-Limestone and Chert; no Rider.

62. Fagnergill New-vein, productive in Main-Limestone and Chert; no Rider.

*Fell-End Mines.*

63. Jingle-Pot vein, productive in Main-Limestone and Chert; Rider.

64. Primrose vein, productive in Main-Limestone and Chert, and Black and Red beds; Rider.

65. Sim Gutter's string, productive in Main-Limestone and Chert, and Black and Red beds; Rider.

---

VEINS OF TWO FATHOMS THROW.—PLATE I.

*West-Swaledale Mines.*

1. North Cross vein (Stonesdale), productive in Main-Chert; no Rider.

*Blakethwaite Mines.*

2. Middle Branch, North vein, productive in Main-Limestone and Chert; Rider.

3. Sun vein or Dean's vein, productive in Main-Limestone and Chert; strong Rider.

4. Sun vein, productive in Main-Limestone and Chert; no Rider.

*Old Gang Mines.*

5. Freeman vein, productive in Main-Limestone and Chert; Rider.

6. Dean's vein, productive in Red-beds; Rider.

7. Nathan vein, productive in Main-Limestone and Chert; Rider.

8. Hazel-Keld vein, productive in Main-Limestone and Chert, and Black-beds; Rider.

9. Ensley vein, productive in Main-Limestone and Chert, and Black-beds; strong Rider.

10. Rose vein, productive in Main-Limestone and Chert; not much Rider.

11. Knotts vein, productive in all the principal bearing beds; not much Rider.

*Surrender Mines.*

12. Rachael string, productive in Main-Limestone and Chert, and Crow-beds; not much Rider.

13. South Middle vein, productive in Main-Limestone and Chert, Black-beds and Crow-beds; not much Rider.

14. North Middle vein, productive in Main-Limestone and Chert, and Crow beds; strong Rider.

15. Jacob North vein, productive in Main-Limestone and Chert, Black-beds and Crow-beds; strong Rider.

16. Jacob Sun vein, productive in Main-Limestone and Chert, and Crow-beds; Rider.

*Hurst Mines.*

17. Jingle-Pot vein, productive in Main-Limestone and Chert, and Black and Red beds; Rider.

18. Hawkin string, productive in Main-Limestone and Chert, Red-beds, ten fathoms Grit and Crow-beds; Rider.

19. Sun Hush vein, productive in Main-Limestone and Chert; Rider.

20. Strings, Pries' vein, productive in Underset-Limestone and Chert; Rider.

*Arkengarthdale Mines.*

21. New Rake vein, productive in Main-Limestone, Black-beds and Crow-beds; Rider.

22. Peat-Stack vein, productive in all the principal bearing beds; Rider.

23. Cocker Sun vein, productive in Main-Limestone and Chert; no Rider.

24. Bishop North vein, productive in Main-Limestone and Chert; no Rider.

25. Grey Game vein, unproductive.

26. Bishop Sun vein, unproductive.

*Fell-End Mines.*

27. Slack vein, productive in Main-Limestone and Chert, and Black and Red beds; Rider.

28. Sun Gutters strings, productive in Main-Limestone and Chert, and Black and Red beds; Rider.

## VEINS OF THREE FATHOMS THROW.—PLATE I.

*West-Swaledale Mines.*

1. Sun vein (Keld Side), productive in Main-Limestone and Chert; Rider.

*Blakethwaite Mines.*

2. Red Sun vein, productive in Main-Limestone and Chert; little or no Rider.
3. Middle vein (Swinnergill), productive in Main-Limestone and Chert; Rider.
4. Sun vein (Swinnergill), productive in Main-Limestone and Chert; Rider.
5. East Arngill vein, productive in Underset-Limestone and Chert; no Rider.

*Old Gang Mines.*

6. Kinning vein, productive in Main-Limestone and Chert; Rider.
7. Barbara vein, productive in Main-Limestone and Chert, and Black and Red beds; Rider.
8. Morey vein, productive in Main-Limestone; no Rider.
9. Merry-Field vein, productive in Main-Limestone and Chert; Rider.
10. Barras-End vein, productive in Main-Limestone and Chert, and Underset-Limestone and Chert; Rider.

*Surrender Mines.*

11. South Middle vein, productive in Main-Limestone and Chert, Black-beds and Crow-beds; not much Rider.
12. Flange vein, productive in Main-Limestone and Chert, and Crow-beds; strong Rider.

13. North Middle vein, productive in Main-Limestone and Chert, and Crow-beds; strong Rider.

14. Jacob North vein, productive in Main-Limestone and Chert, Black-beds and Crow-beds; strong Rider.

15. Grey Game vein, productive in Main-Limestone and Chert; strong Rider.

*Hurst Mines.*

16. Trench vein, productive in Red-beds; Rider.

*Arkengarthdale Mines.*

17. Jacob vein, productive in Main-Limestone and Chert, and Black and Red beds; Rider.

18. Dodgson vein, productive in Main-Limestone, and Chert, and Black-beds; Rider.

19. Folly vein, productive in all the principal bearing beds; Rider.

20. Band vein, productive in all the principal bearing beds; Rider.

21. Sun vein, productive in all the principal bearing beds; Rider.

22. Luke vein, productive in all the principal bearing beds; Rider.

23. Cocker Sun vein, productive in Main-Limestone and Chert; no Rider.

24. Cocker North vein, productive in Main-Limestone and Chert; no Rider.

*Fell-End Mines.*

25. Scarry vein, productive in Underset-Limestone and Chert, Main-Limestone and Chert, and Black and Red beds; Rider.

26. Slack vein, productive in Main-Limestone and Chert, and Black and Red beds; Rider.



## VEINS OF FOUR FATHOMS THROW.—PLATE I.

*Blakethwaite Mines.*

1. North vein, productive in Main-Limestone and Chert; Rider.
2. Water Sykes vein, productive in Main-Limestone and Chert; no Rider.
3. North vein (Lownithwaite), productive in Main-Limestone and Chert, and Underset-Limestone and Chert; Rider.
4. Silver Hill vein, productive in Main-Limestone and Chert; Rider.

*Old-Gang Mines.*

5. Barbara vein, productive in Main-Limestone and Chert, and Black and Red beds; Rider.
6. Gorton vein, productive in Main-Limestone and Chert, and Underset-Limestone and Chert; not much Rider.

*Surrender Mines.*

7. Flange vein, productive in Main-Limestone and Chert, and Crow-beds; strong Rider.
8. North vein, productive in Main-Limestone and Chert, and Crow-beds; strong Rider.

*Hurst Mines.*

9. Copperthwaite vein, productive in Underset-Limestone and Chert, Main-Limestone and Chert, and Black and Red beds; Rider.
10. Golden vein, productive in Red-beds and Crow-beds; Rider.

*Arkengarthdale Mines.*

11. Folly vein, productive in all the principal bearing beds;

12. Luke vein, productive in all the principal bearing beds, Rider.

*Fell-End Mines.*

13. Copperthwaite vein, productive in all the principal bearing beds where seen; Rider.

---

VEINS OF FIVE FATHOMS THROW.—PLATE II.

*Blakethwaite Mines.*

1. North vein, productive in Main-Limestone and Chert; Rider.

2. Water Sykes vein, productive in Main-Limestone and Chert; no Rider.

*Old-Gang Mines.*

3. Old Rake vein, productive in all the principal bearing beds; Rider.

4. Sun vein, productive in Main-Limestone and Chert, and Underset-Limestone and Chert; Rider.

*Hurst Mines.*

5. Scott or Wagget vein, productive in Underset-Limestone and Chert, Main-Limestone and Chert, and Red-beds; Rider.

6. Golden vein, productive in Red-beds and Crow-beds; Rider.

---

VEINS OF SIX FATHOMS THROW.—PLATE II.

*Blakethwaite Mines.*

1. North vein (Swinnergill), productive in Main-Limestone and Chert; Rider.

*Beldi-Hill Mines.*

2. Middle vein, productive in Main-Limestone and Chert Red-beds and Crow-beds; no Rider.
3. Sun vein, productive in Main-Limestone and Chert, and Crow-beds; no Rider.

*Hurst Mines.*

4. Scott or Waggett vein, productive in Underset-Limestone and Chert, and Red-beds; Rider.
5. Woodgarth vein, productive in Red-beds; Rider.

*Whitaside Mines.*

6. Harker's vein, unproductive.

*Arkengarthdale Mines.*

7. Foregill Sun vein, productive in Main-Limestone and Chert, and Black-beds; no Rider.
8. Stoddart vein, productive in all the principal bearing beds; Rider.
9. Martin vein, productive in all the principal bearing beds; Rider.

---

VEINS OF SEVEN FATHOMS THROW.—PLATE II.

*West-Swaledale Mines.*

1. Middle vein (Littlemoor), productive in Main-Limestone and Chert; Rider.

*Blakethwaite Mines.*

2. West Arngill vein, unproductive.

*Hurst Mines.*

3. Woodgarth vein, unproductive.

VEINS OF EIGHT FATHOMS THROW.—PLATE II.

*West-Swaledale Mines.*

1. North vein (Little Moor), unproductive.
2. North vein (Lane End), productive in Ten-Fathoms Grit ; Rider.

*Blakethwaite Mines.*

3. Sun vein (Lownithwaite), productive in Main-Limestone and Chert ; no Rider.
4. West Arngill vein, unproductive.

*Grinton-Moor Mines.*

5. Harker vein, productive floats in principal beds ; no Rider.

*Arkengarthdale Mines.*

6. Foregill North vein, productive in Main-Limestone and Chert, and Black-beds ; no Rider.

---

VEINS OF NINE FATHOMS THROW.—PLATE III.

*Old-Gang Mines.*

1. Water Sykes vein, productive in Underset-Limestone and Chert, and Red-beds ; Rider.

*Hurst Mines.*

2. Cleminson vein, productive in Main-Limestone and upper beds ; Rider.

---

VEINS OF TEN FATHOMS THROW.—PLATE III.

*West-Swaledale Mines.*

1. Blakethwaite vein, unproductive.

*Beldi-Hill Mines.*

2. Middle vein, productive in Main-Limestone and Chert, Red-beds and Crow-beds; no Rider.

3. Sun vein, productive in Main-Limestone and Chert, and Crow-beds; no Rider.

*Hurst Mines.*

4. Scott or Waggett vein, productive in Underset-Limestone and Chert, and Red-beds; Rider.

5. Woodgarth vein, productive in Red-beds; Rider.

*Whitaside Mines.*

6. Harker's vein, unproductive.

*Arkengarthdale Mines.*

7. Foregill Sun vein, productive in Main-Limestone and Chert, and Black-beds; no Rider.

8. Stoddart vein, productive in all the principal bearing beds; Rider.

9. Martin vein, productive in all the principal bearing beds; Rider.

---

VEINS OF SEVEN FATHOMS THROW.—PLATE II.

*West-Swaledale Mines.*

1. Middle vein (Littlemoor), productive in Main-Limestone and Chert; Rider.

*Blakethwaite Mines.*

2. West Arngill vein, unproductive.

*Hurst Mines.*

3. Woodgarth vein, unproductive.

VEINS OF EIGHT FATHOMS THROW.—PLATE II.

*West-Swaledale Mines.*

1. North vein (Little Moor), unproductive.
2. North vein (Lane End), productive in Ten-Fathoms Grit ; Rider.

*Blakethwaite Mines.*

3. Sun vein (Lownithwaite), productive in Main-Limestone and Chert ; no Rider.
4. West Arngill vein, unproductive.

*Grinton-Moor Mines.*

5. Harker vein, productive floats in principal beds ; no Rider.

*Arkengarthdale Mines.*

6. Foregill North vein, productive in Main-Limestone and Chert, and Black-beds ; no Rider.

VEINS OF NINE FATHOMS THROW.—PLATE III.

*Old-Gang Mines.*

1. Water Sykes vein, productive in Underset-Limestone and Chert, and Red-beds ; Rider.

*Hurst Mines.*

2. Cleminson vein, productive in Main-Limestone and upper beds ; Rider.

VEINS OF TEN FATHOMS THROW.—PLATE III.

*West-Swaledale Mines.*

1. Blakethwaite vein, unproductive.

*Fell-End Mines.*

2. Hind Rake vein, productive in Main-Limestone and Chert, and Black and Red beds ; Rider.
- 

## VEINS OF ELEVEN FATHOMS THROW.—PLATE III.

*Fell End Mines.*

1. Hind Rake vein, productive in Main-Limestone and Chert, and Black and Red beds ; Rider.
- 

## VEINS OF TWELVE FATHOMS THROW.—PLATE III.

*Blakethwaite Mines.*

1. North vein (Lownithwaite), productive in Twenty-seven-fathoms Grit ; strong Rider.
2. Barbara vein (Lownithwaite), unproductive.

*Hurst Mines.*

3. Shaw vein, unproductive.
4. Miles Rake vein, unproductive.

*Whitaside Mines.*

5. Whitaside vein, productive in Main-Limestone ; no Rider.

*Arkengarthdale Mines.*

6. Damrigg vein, productive in all the principal bearing beds ; Rider.

*Fell-End Mines.*

7. Hind Rake vein, productive in Main-Limestone and Chert, and Black and Red beds ; Rider.

VEINS OF THIRTEEN FATHOMS THROW.—PLATE IV.

*Blakethwaite Mines.*

1. Hurras vein, unproductive.
- 

VEINS OF FOURTEEN FATHOMS THROW.—PLATE IV.

*Hurst Mines.*

1. Redshaft vein, productive in Underset-Limestone and Chert, and upper beds; strong Rider.
- 

VEINS OF FIFTEEN FATHOMS THROW.—PLATE IV.

*Hurst Mines.*

1. Redshaft vein, productive in Underset-Limestone and Chert, and upper beds; strong Rider.

*Arkengarthdale Mines.*

2. Freeman vein, productive in Main-Limestone and Chert, and Black-beds; no Rider.

*Fell-End Mines.*

3. North-Gutters vein, productive in Main-Limestone and Chert; Rider.
- 

VEINS OF SIXTEEN FATHOMS THROW.—PLATE IV.

*Hurst Mines.*

1. North vein (Marrick), productive in Crow-beds; Rider.



2. Wellington vein, productive from the Underset-beds to the Crow-beds; Rider.

3. Wall Nook vein, unproductive.

*Fell-End Mines.*

4. North-Gutters vein, productive in Main-Limestone and Chert; Rider.

*No veins recorded of seventeen fathoms throw.*

---

VEINS OF EIGHTEEN FATHOMS THROW.—PLATE V.

*Arkengarthdale Mines.*

1. Stang vein, unproductive.

*No veins recorded of nineteen, twenty, twenty-one, twenty-two, twenty-three, twenty-four, and twenty-five fathoms throw.*

---

VEINS OF TWENTY-SIX FATHOMS THROW.—PLATE VII.

*Arkengarthdale Mines.*

1. Geordy vein, productive in Main-Limestone and Chert, and Black-beds; no Rider.

2. Moulds vein, productive in Main-Limestone and Chert, Black and Red beds, and Ten Fathoms Grit; Rider.

---

VEINS OF TWENTY-SEVEN FATHOMS THROW.—PLATE VII.

*Grinton-Moor Mines.*

1. Old Stork vein, productive in all bearing beds; no Rider.

*Ellerton-Moor Mines.*

2. Old Stork vein, productive in Underset-Limestone and Chert, Main-Limestone and Chert, and Crow-beds; no Rider.

VEINS OF TWENTY-EIGHT FATHOMS THROW.—PLATE VII.

*Beldi-Hill Mines.*

1. North vein, productive in Main-Limestone and Ten-Fathoms Grit ; Rider.

*Old-Gang Mines.*

2. Fryerfold vein, productive in all the principal bearing beds ; Rider.

*Surrender Mines.*

3. Great Sun vein, productive in all the principal bearing beds ; strong Rider.

*Fell-End Mines.*

4. Wellington vein, productive in all the principal bearing beds ; Rider.

VEINS OF THIRTY TO FORTY FATHOMS THROW.—

PLATES VIII. TO X.

*Hurst Mines.*

1. Marrick Great Sun vein, unproductive.
2. Moresdale-Ridge vein, unproductive.

*Arkengarthdale Mines.*

3. Windegg vein, unproductive.
4. Black-Side vein, productive in all the principal bearing beds ; Rider.

## CHAPTER IV.

## SYNOPSIS OF RETURNS.

ON examining these returns we find, in the first place, that there are no less than 192 distinct veins in Swaledale already more or less explored by the miner, and distributed over an area of about 200 square miles. In the second place we find that out of these 192 veins no less than 170 are returned as *productive*,\* and the remaining 22 as *unproductive*, at least so far as explorations have hitherto been prosecuted in them. But there is good reason to believe that even this number will, ere long, be considerably decreased, for we know that year after year fresh trials are made (as opportunities arise, and circumstances facilitate research,) of the so called unproductive veins in *different localities*, in *different beds*, and under *different dislocations of the veins*; and, as a consequence of these differences, we may (judging from former experience) anticipate more successful results. For it has been clearly proved, and is generally received as a matter of fact amongst miners, that all veins have their productive and unproductive lengths; that is to say, that veins which have been found productive in one locality do not

---

\* By the word "*productive*," let it be understood that I do not mean to convey any opinion whether the vein is or is not remunerative or profitable in a money point of view, but merely that it is productive, more or less, of metallic ore; the object in this case being to ascertain in what beds and under what conditions the veins of this district are most productive of lead-ore.

maintain their productive character uninterruptedly along the whole of their course. They assume changes of a non-metaliferous character, which are produced by an alteration in the direction of the veins. Such changes are also brought about by the union or disunion of the vein or veins; and all veins, in traversing a country, are subject to an increase or decrease in the amount of their throws; and, as a rule, their being *productive* or *non-productive*, depends upon *their Throws and the formation of Riders* (veinstone).

That Riders perform a very important part or function in the formation of lead-ore there cannot be the least doubt, for out of the 22 *unproductive veins* here recorded 19 are returned as carrying little or no *mineral matter* (*i.e.* Riders); most of the veins being filled with Black-Sample (*i.e.* decomposed Plate or Shale, called Douk, a soft clayey matter); and three other veins possessing a little "Spar," "Water-Spar," and "Strong-Spar," chiefly calcareous Spar the result of water percolation through the Limestones and its action on the carbonate of lime. If now we examine the *productive veins*, we shall find that no less than 120 are *productive in the presence of a Rider*, whilst, out of the 50 veins returned as *productive without Riders* no less than 21 are *productive floats or flats* attending the veins, and not the veins themselves. The remaining 29 veins have been mostly productive in the Main-Limestone accompanied with red Whamp or Vamp (*i. e.* decomposed Limestone), a soft ferruginous soil rendered red in colour through the oxidation of the iron associated with the Limestone. If we now proceed to examine still further in what *beds* and under what circumstances the veins of this district have been *most productive*, we shall find that, out of the 170 veins returned as productive, no less than 148 are productive in the *Main-Limestone and Chert*; 96 are productive in the top beds (that is to say, the Crow-Limestone and Chert,

Ten-Fathoms Grit, Red-beds and Black-beds); whilst only 40 have been found productive in the Underset-Limestone and Chert.

For convenience in studying the productive portions of the veins, as influenced by the adjacent strata, it will be necessary to divide the beds into three divisions:—

*1st. The Top Sets.*

In these are included the Crow-Chert and Limestone, Ten-Fathoms Grit, Iron-beds, Red-beds Limestone, Black-beds and Thin Limestone.

*2nd. The Main Sets.*

These include the Main-Limestone and Chert.

*3rd. Under Sets.*

Included in these are the Underset-Limestone and Chert and the Twenty-seven-Fathoms Grit.

THE TOP-SETS.

Out of the 170 veins returned as *productive*, only 96 have been proved productive in these beds; and those principally in veins with *small throws or slips* varying from one to four fathoms; for within this range we possess 64 productive veins out of the 96 just mentioned. Again, out of the 96 veins thus recorded as productive in the top beds, the large number of 78 *are returned as carrying Riders*; the 18 veins *without Riders* are principally included under the first head consisting of veins of One-fathom throw and under, wherein are reckoned small strings, flanges and lappings attending the principal veins. It is also not uncommon to find in these small veins or strings ribs of ore, sometimes with and sometimes without any mineral matter, in the form of a rider associated with the lead-ore. Then, again, there are occasional floats or

flats attending the veins in the Red-beds limestone, and in which floats the ores are invariably imbedded in a soft red clay or soil known to the north-country miner as "Whamp."

#### THE MAIN SETS.

We have here again to take as our standard 170 *productive veins*; and out of these we find the large number of 148 *returned as productive* in the Main-Limestone and Chert, and out of the 148 productive veins we have 108 *productive in the presence of a Rider*, while the remaining 40 are mostly floats or flats in the Main-Limestone and branches of the Main veins. It is a somewhat singular fact that the veins on the south side of the River Swale are mostly float or flat veins—that is to say, the ore is deposited in caverns in the Limestone; while on the north side of the river the float or flat veins are the exception, and veins attended with strong Riders the rule.

#### THE UNDER SETS.

Taking the 170 *productive veins*, it is found that in these beds only 40 are *returned as productive*, and that out of that number no less than 34 are *productive in the presence of a Rider*; showing, from this fact alone, that it is almost necessary veins should carry Riders to be productive in the lower beds. From this summary we will next proceed to examine all the veins returned from one fathom throw and under, to forty fathoms.

#### VEINS OF ONE FATHOM THROW AND UNDER.

Under this head we find 65 *veins* recorded, 63 of which have been found *productive* and 2 unproductive. Of the former 36 are *productive in the presence of a Rider*, and 27 without Riders; 26 are productive in the Top Sets, (16 with Riders and 10 without); 54 are productive in the Main Sets, (31 with Riders

and 23 without); and 6 are productive in the Under Sets, (4 with Riders and 2 without). It is somewhat singular that the greatest number of productive veins should come under this heading, and that the *strata* in this instance are so formed and placed as to give the greatest extent of bearing surface or ore-producing beds on each side of the vein, amounting to 61 *per cent.*

VEINS OF TWO FATHOMS THROW.

28 veins are recorded, viz :—

26 productive, 2 unproductive.

22 productive with Riders, 4 without.

15 productive in the Top Sets, all carrying Riders.

24 productive in the Main Sets; 20 with Riders, 4 without.

3 productive in the Under Sets; 1 with Rider, 2 without.

*Ore-bearing surface 58 per cent.*

VEINS OF THREE FATHOMS THROW.

26 veins are recorded, all productive, viz :—

21 productive with Riders, 5 without.

14 productive in the Top Sets, all carrying Riders.

23 productive in the Main Sets; 20 with Riders, 3 without.

7 productive in the Under Sets; 6 with Riders, 1 without.

*Ore-bearing surface 55 per cent.*

VEINS OF FOUR FATHOMS THROW.

13 veins are recorded, all productive, viz :—

12 productive with Riders, 1 without.

8 productive in the Top Sets, all carrying Riders.

12 productive in the Main Sets, 11 with Riders, 1 without.

6 productive in the Under Sets, all with Riders.

*Ore-bearing surface 51 per cent.*

VEINS OF FIVE FATHOMS THROW.

6 veins are recorded, all productive, viz. :—  
 5 productive with Riders, 1 without.  
 3 productive in the Top Sets, all with Riders.  
 5 productive in the Main Sets, all with Riders.  
 3 productive in the Under Sets, all with Riders.  
*Ore-bearing surface 48 per cent.*

VEINS OF SIX FATHOMS THROW.

9 veins are recorded, viz. :—  
 8 productive, 1 unproductive.  
 5 productive with Riders, 3 without.  
 7 productive in the top sets; 4 with Riders, 3 without.  
 5 productive in the Main Sets; 3 with Riders, 2 without.  
 3 productive in the Under Sets, with Riders.  
*Ore-bearing surface 42 per cent.*

VEINS OF SEVEN FATHOMS THROW.

3 veins are recorded, viz. :—  
 1 productive in the Main-Limestone and Chert; with strong Rider.  
 2 unproductive, without Rider.  
*Ore-bearing surface 39 per cent,*

VEINS OF EIGHT FATHOMS THROW.

6 veins are recorded. viz. :—  
 4 productive, 2 unproductive.  
 1 productive with Rider, 3 without.  
 3 productive in the Top Sets; 1 with Rider, 2 without.  
 3 productive in the Main Sets; without Riders.  
 1 productive in the Under Sets, without Rider.  
*Ore-bearing surface 37 per cent.*



## VEINS OF NINE FATHOMS THROW.

- 2 veins are recorded, both productive, with Riders.
  - 2 productive in the Top Sets, with Riders.
  - 1 productive in the Main Sets, with Rider.
  - 1 productive in the Under Sets, with Rider.
- Ore-bearing surface 38 per cent.*

## VEINS OF TEN FATHOMS THROW.

- 2 veins are recorded.
  - 1 productive with Rider, in the Top and Main sets.
  - 1 unproductive.
- Ore-bearing surface 35 per cent.*

## VEINS OF ELEVEN FATHOMS THROW.

- 1 productive with Rider, in the Top and Main Sets.
- Ore-bearing surface 32 per cent.*

## VEINS OF TWELVE FATHOMS THROW.

- 7 veins are recorded, viz :—
  - 4 productive, 3 unproductive.
  - 3 productive with Rider, 1 without (floats).
  - 2 productive in the Top Sets, with Rider.
  - 3 productive in the Main Sets ; 2 with Rider, 1 without.
  - 2 productive in the Under Sets, with Rider.
- Ore-bearing surface 26 per cent.*

## VEINS OF THIRTEEN FATHOMS THROW.

- 1 vein returned unproductive.
- Ore-bearing surface 31 per cent.*

NOTE.—The Main Sets just pass each other with this throw.

VEINS OF FOURTEEN FATHOMS THROW.

1 vein returned productive in the Top, Main and Under Sets,  
with Rider.

*Ore-bearing surface 39 per cent.*

VEINS OF FIFTEEN FATHOMS THROW.

3 veins are recorded, productive, viz :—

2 productive with Riders, 1 without.

2 productive in the Top Sets ; 1 with Rider, 1 without

3 productive in the Main Sets ; 2 with Riders, 1 without.

1 productive in the Under Sets, with Rider.

*Ore-bearing surface 40 per cent.*

VEINS OF SIXTEEN FATHOMS THROW.

4 veins are recorded.

3 productive, 1 unproductive.

3 productive with Riders.

2 productive in the Top Sets, with Rider.

2 productive in the Main Sets, with Rider.

1 productive in the Under Sets, with Rider.

*Ore-bearing surface 41 per cent.*

NOTE.—The only unproductive vein is the one not carrying a Rider.

VEINS OF SEVENTEEN FATHOMS THROW.

No veins are recorded with this throw.

VEINS OF EIGHTEEN FATHOMS THROW.

1 vein returned unproductive.

No veins are recorded with throws between 18 and 26 fathoms ;  
we may therefore conclude that none are known to exist in  
Swaledale, a fact I was not aware of at the time the Sections

were made, nor had I any means of knowing it until I received the returns from each mining field.

VEINS OF TWENTY-SIX FATHOMS THROW.

2 veins are recorded, both productive in the Top and Main Sets.

1 with Rider, 1 without.

*Ore-bearing surface 34 per cent.*

VEINS OF TWENTY-SEVEN FATHOMS THROW.

2 veins are recorded, both productive in the Top and Main Sets, without Rider (floats).

*Ore-bearing surface 33 per cent.*

VEINS OF TWENTY-EIGHT FATHOMS THROW.

4 veins are recorded, all productive in the Top and Main Sets, with Rider.

3 productive in the Under Sets, with Rider.

*Ore-bearing surface 31 per cent.*

NOTE.—An instance of veins bearing through the whole Set when accompanied by a *strong mineral Rider*.

VEINS WITH THROWS VARYING FROM THIRTY TO FORTY FATHOMS.

4 veins are recorded, viz :

3 unproductive, no Rider.

1 productive in the Top, Main and Under Sets, with Rider.

*Ore-bearing surface 27 per cent.*

NOTE.—The only productive vein with this enormous throw is the one carrying a

## CHAPTER V.

## GENERAL SUMMARY.

FROM the foregoing statements we arrive at the following conclusions:—

## REGARDING VEINS.

1st. That veins of small throws are the most productive of Lead-ore.

2nd. That veins of small throws have a general bearing of W. and S.W. to E. and N.E.

3rd. That veins of small throws are the most productive of Lead-Ore, from having Ore-bearing or Ore-producing beds on each side of the vein, opposite or nearly so to each other.

4th. That veins of small throws invariably carry a primary, a secondary, or a compound Rider.

5th. That veins of large throws are generally cross veins, and have a direction N. and S., or N.W. and S.E.

6th. That veins of large throws are invariably unproductive, because the ore-bearing beds are thrown past each other.

7th. That cross veins of large throws when productive of lead-ore are usually so in the Limestones accompanied with a tertiary Rider.

8th. That East and West Veins of large throws when productive of Lead-Ore usually bear through the whole strata (Top Sets, Main Sets, and Under Sets), accompanied by a Primary, a Secondary, or a Compound Rider.\*

## REGARDING BEDS.

LIMESTONES *and* CHERTS are the *productive deposits*, GRITS and PLATES the *unproductive*.

\* See Synopsis of returns page 38, veins of 28 to 40 fathoms throw.

*Limestones and Cherts* are the *most productive*, because

- 1st. They are calcareous in their composition.
- 2nd. They possess the greatest specific gravity.
- 3rd. They are the hardest deposits.
- 4th. They are conductors of heat and electricity.
- 5th. They are of the most compact structure.
- 6th. They contain a very small per centage of water.

*GRITS and PLATES* are the *unproductive deposits*, because

- 1st. They are silicious or argillaceous in their composition.
- 2nd. They are of a smaller or less specific gravity.
- 3rd. They are more porous.
- 4th. They are imperfect conductors of heat and electricity.
- 5th. They contain a much larger per centage of water.

I have now laid before the reader some of the general characteristics and peculiarities of the veins of Swaledale; and though these pages possess no other merit they at least tend to prove by the evidence collected that certain natural laws and rules are found to govern the formation of veins and their mineral products, a point on which considerable doubt has hitherto existed.

From the amount of information in my possession the inquiry might easily have been extended to a much greater length, but I have restricted myself to the statement of facts, and carefully refrained from introducing any speculations of my own, though the nature of the subject afforded much scope for so doing.

In conclusion, I wish to repeat that the chief object I proposed in this investigation was that of aiding, if possible, the establishment of some useful data for the guidance of the practical miner, for the more easy discovery of the productive character of veins, and for saving the risk of capital in unprofitable speculations.

THE END.





553.44 .B811 C.1  
An inquiry into the deposition  
Stanford University Libraries



3 6105 032 153 483

